Infrared Distance Sensors

This section shows how to connect an infrared distance sensor to the CSM-12C32 module and provide the C-codes for initializing one of its analog-to-digital channel for capturing the analog voltage from the infrared sensor and for converting the analog voltage into numerical distance.

A typical infrared distance sensor is Sharp GP2D12- general purpose type distance measuring sensor. Pictures, ordering information and web link of the datasheet are shown below.

![Infrared Distance Sensor](source: GP2D12 datasheet)

<table>
<thead>
<tr>
<th>Vendor</th>
<th>Part Number</th>
<th>Weblink for datasheet</th>
<th>Description</th>
<th>Unit Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lynxmotion</td>
<td>Sharp gp2d12 ir Sensor</td>
<td><a href="http://www.lynxmotion.com/Product.aspx?productID=260">http://www.lynxmotion.com/Product.aspx?productID=260</a> &amp;CategoryID=8</td>
<td>Detects objects in a range: 4 cm to 40 cm</td>
<td>$14.95</td>
</tr>
</tbody>
</table>

Hardware interfacing to the Freescale 9S12C32 MCU on board the CSM-12C32 module

There are three pins on the GP2D12. Two of them are 5 Vdc and ground inputs. The third pin is analog output voltage that indicates the measured distance. The wiring diagram for interfacing the distance sensor to CSM-12C32 is shown below. The capacitor between the IOLine and ground is recommended. An electrolytic capacitor of 4.7 uF works. This capacitor reduces noise on the analog voltage by coupling the noise to ground. The analog voltage at the IOLine can be connected to any of the ADC channel of the MCU. In the wiring diagram below, the IOLine is shown as being routed to channel 0 of the ADC. The unconditioned analog voltage at IOLine is
in the range of 2.4 V to 0.4 V corresponding to 10 cm to 80 cm. A graph of the analog output voltage to distance is shown below.

Source: GP2D12 datasheet and CSM-12C32 user’s manual

**Analog Output Voltage vs. Distance to Reflective Object**

<table>
<thead>
<tr>
<th>GP2D12</th>
<th>Draft Reflectivity</th>
</tr>
</thead>
<tbody>
<tr>
<td>White</td>
<td>90%</td>
</tr>
<tr>
<td>Gray</td>
<td>18%</td>
</tr>
</tbody>
</table>

Source: GP2D12 datasheet
Software development

The C function below can be used for initializing the ADC of the MCU. It is assumed that the analog voltage is fed to the channel 0 of the ADC module. Other assumptions are included in the comment statements. The code snippet can be easily modified for other conversion settings.

```c
void initADC(void) {
    ATDCTL2 = 0x80;   // turn on ADC ATDCTL2_ADPU=1
    ATDCTL3 = 0x08;   // 1 conversion/sequence
    ATDCTL4 = 0x81;   // 8-bit conv., 2Mhz ADC clock, fastest conv.
    ATDCTL5 = 0x00;   //left justify, unsigned, non-scanning, non-multichannel
    return;
}
```

A C function for reading the analog voltage of the GP2D12 is shown below. The delay for 1 ms in the function is to give sufficient time for the distance sensor to finish the measurement. Every execution of this function will result in a new distance reading stored in the variable distance.

```c
void readDist(void) {
    int distance;

    ATDCTL5 = 0x00;   // initiate ADC conversion
    waitms(1);       // delay 1 ms, this function was covered in class
    distance = ATDDR0;    // read temperature
    return distance;
}
```

To determine the distance from the analog voltage of the GP2D12 sensor, one needs to determine the equation of the graph of analog output voltage (V) vs. distance to reflective object (L) as shown above. This equation can be obtained by inputting the data points into a spreadsheet program, e.g., Excel, and use its functions to determine the equation.

Another approach is to store the data points into the microcontroller and use interpolation to determine the distance.